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Health Symptoms Reported by Persian Gulf War Veterans Two Years After Return

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The role of actual or perceived events has considerable importance for individual well-being. Although the Persian Gulf War (PGW) has raised questions about the presence of hazardous environmental exposures, few, if any confirmed exposure data are available. Yet, a substantial number of PGW veterans report health problems since their return from that war. The present study was conducted to investigate possible associations between opportunities for exposure and increased rates of health symptom reporting. First, we examined descriptive data on types and rates of health symptoms reported by a cohort of Gulf War veterans. Then, using proxies for three wartime experiences, we examined associations between health symptoms reports and different Persian Gulf exposure scenarios (reported exposure to poison gas or germ warfare, being in a transportation unit, or high levels of combat exposure), adjusting for the effects of background characteristics (e.g., gender, psychological distress). Findings suggest that reported exposure to poison gas or germ warfare is related to higher symptom reporting by this cohort of New England area veterans. Limitations in the study design and the challenges involved in studying PGW veterans' illnesses are discussed. Am. J. Ind. Med. 33:104–113, 1998. © *1998 Wiley-Liss, Inc.*

KEY WORDS: Persian Gulf War; environment; stress; health; toxicology; outcomes

INTRODUCTION

Despite the war's brevity and the limited number of troop casualties, reports show that American Persian Gulf War (PGW) veterans describe adverse physical health changes since the war [e.g., DeFraites et al., 1992; MMWR, 1995]. The more common symptoms include excessive fatigue, memory disturbance, concentration difficulties, skin rash, diarrhea and gastrointestinal complaints, muscle soreness, joint pain, shortness of breath, and headaches. The duration of these health problems appears considerable: almost 6 years after the war's conclusion, veterans' health concerns still persist [Haley et al., 1997; Iowa Persian Gulf Study Group, 1997].

A number of etiologies for health problems have been proposed, ranging from airborne/environmental factors (e.g., petrochemicals from burning oil wells) to infectious parasitic agents (e.g., *Leishmaniasis tropica*) [Hyams et al., 1995]. Other possible causes include purported exposure to predeployment or theater vaccines (e.g., anthrax), anti-nerve gas agents (e.g., pyridostigmine bromide) [Almog et al., 1991; Keeler et al., 1991] taken by an undetermined number of veterans, or the possible exposure of some soldiers to biological or chemical warfare during the deployment (e.g., sarin), either from weapons used by Iraqis or from Allied-based destructions of Iraqi munitions plants as was recently announced [Joseph, 1996].

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Several studies report a spectrum of health problems that are as diverse as respiratory tract infections [Korenyi-Both et al., 1992], diarrheal outbreaks and gastroenteritis [Hyams et al., 1991], visceral leishmaniasis [Magill et al., 1993], and chronic fatigue, with some variations depending on the unit studied (possibly reflecting occupational status or troop location in the Gulf). Recently, three panels of experts from the Presidential Advisory Committee on Gulf War Veterans' Illnesses [1996], the National Institutes of Health Technology Assessment Workshop Panel [1994], and the Institute of Medicine [1995] have concluded that the pattern of reported symptoms in PGW veterans overall seemed inconsistent with any single diagnostic entity.

The absence of data on confirmed exposures during the Gulf War poses difficulties in examining potential associations between deployment experiences and subsequent outcomes. Investigations in environmental and occupational health have successfully used surrogate measures, including self-report, occupational code, or location information such as proximity to hazardous waste sites, as proxies for hazardous environmental exposures (e.g., Agent Orange in Vietnam) [Bullman et al., 1994]. The range of differing occupational experiences among PGW soldiers may provide a similar opportunity. For example, data collected early upon return concerning veterans' perceptions of exposure to biological or chemical warfare could serve as a proxy for assessing hazardous environmental exposures during that deployment. Second, data from particular military occupational classes might also contribute information about possible hazards. For example, occupational studies have shown that surrogate measures of workplace exposures to toxicants (i.e., job titles and job exposure matrices) [Stengel et al., 1993] have value in evaluations of work-related, adverse health outcomes over time. Finally, combat participation may be a factor to examine in assessing health outcomes. A large number of studies have shown that exposure to combat is widely associated with increased reporting of poor health outcomes across a variety of symptoms and body systems [Kulka et al., 1990; Litz et al., 1992; Friedman and Schnurr, 1995], as well as increased use of health services. Although these effects appear to be largely mediated through the development of post-traumatic stress disorder (PTSD) [Shalev et al., 1990; Wolfe et al., 1994], reports of combat activity could be examined for their association with traumatic stress and health reports.

For the present study, we examined data collected two years after return from the Gulf, from a cohort of PGW veterans who returned through Ft. Devens, MA [Wolfe et al., 1992], to ascertain possible relationships between war experiences and subsequent health symptom reporting. We chose to investigate three, nonmutually exclusive categories as exposure proxies, each reflecting different mechanisms of action based on conceptual models or empirical findings on exposure risks. One event we examined was self-reported exposure to poison gas or germ warfare. At the time this survey was conducted, there were no confirmed biological or chemical warfare exposure data from the PGW; however, it was suspected to be a potential exposure. We chose membership in a wartime transportation unit as another exposure class, as data from a number of transportation units suggest that soldiers in these units perform similar job tasks involving frequent contact with occupational hazards (i.e., refueling, engine repair, and maintenance) shown to have health effects (e.g., solvents). Finally, we selected combat exposure as the third exposure category because of its robust association with PTSD and the latter's well-demonstrated contribution to a variety of health problems, ranging from individual symptoms to increased health services utilization.

The study had three aims: (1) to describe levels and types of health symptoms reported by a large sample of PGW veterans with varying war experiences; (2) to examine associations between health symptom reports and the three types of wartime exposure; and (3) to examine the relationship among certain veteran characteristics (e.g., PTSD, psychological distress, gender) to reporting of physical health. We expected that each exposure class would be associated with increases in health symptom reporting. However, we anticipated that the association between combat exposure and increased health symptoms would be influenced by PTSD symptomatology.

MATERIALS AND METHODS

Subjects

Subjects were from the Ft. Devens ODS Reunion Survey, a longitudinal study of 2,949 U.S. Army Active, Reserve and National Guard soldiers who were deployed to the Persian Gulf during the 1990–1991 conflict. The cohort has been followed since their return; an initial survey on adjustment (Time 1) was conducted within 5 days of returning to this country before soldiers rejoined their families [Wolfe et al., 1992]. Results at the time focused primarily on psychosocial and family adjustment and found that approximately 4% of the sample had symptoms of PTSD. No assessment of individual health symptomatology was collected at Time 1. Subjects in the original cohort are predominantly male (91.8%) and Caucasian (82.8%).

At 18–24 months post-return, we conducted the Time 2 follow-up of this cohort. Nearly 79% of the original cohort completed the re-evaluation (n = 2,313) that focused on psychological and physical health status. In addition, more extensive data on a spectrum of wartime exposures were obtained [Wolfe et al., 1993]. Comparison of the Time 2 respondents and the nonrespondents indicated that Time 2 nonrespondents were more likely to be on active duty status (53% vs 21% for respondents; $\chi^2 = 250.3$, $P < 0.001$) and African-American (17% vs 6% for respondents; $\chi^2 = 75.9$,

included in the regression model examining whether reported exposure to poison gas predicted a higher risk of health symptom reporting.

To investigate the three hypotheses concerning the role of wartime exposures on high health symptom endorsement versus no symptoms reported, first, univariate regression models were run. Then, multivariate logistic regression models were constructed to predict the risk of reporting high symptoms versus no symptoms. Each model began by forced entry of the wartime exposure variable of interest, and then employed a saturated model including terms for age, gender, education level, race, marital status, employment status, service duty status, time in Gulf, number of traumatic stressor events post-Gulf, current drug and alcohol status, PTSD symptomatology, and current depression and somatization status as measured by the BSI subscales. Final models were obtained by applying a backward elimination procedure (P-value to enter: 0.15; P-value to be removed: 0.20) until the process terminated because the log likelihood decreased by less than 0.01%. Evidence for interaction with PTSD status was tested by forcing the product covariates (i.e., the wartime exposure variable times the indicator variable for presumptive PTSD) into the respective final models.

Odds ratios (ORs) and 95% confidence intervals (CIs) are presented to reflect the likelihood that high symptom group membership was associated either with self-reported exposure to poison gas, with transportation unit membership, or with high levels of combat exposure.

RESULTS

When Health Symptom Checklist item responses were dichotomized as described above, the mean number of total health symptoms endorsed was 2 (SD = 3.4), with a median of 1 (range 0–19). Thirteen percent of the total sample (n = 275) reported more than five health symptoms (mean +1 SD) during the preceding several weeks; nearly one-half of the sample (47.6%, n = 1,008) reported no symptoms. Subjects reporting greater than five health symptoms (designated the high symptom group) did not differ significantly in age, education, marital status, or race from those reporting either moderate or no symptoms (Table I), but they were more likely to be female, unemployed, have more alcohol problems and drug problems, and to be Reserve and Guard members. The high symptom group also reported higher rates of combat exposure, higher Mississippi Scale PTSD scores, more psychological symptoms (specifically on the depression and somatization subscales of the BSI), lower social support, more life stressor events since returning from the Gulf, and a longer duration in the Gulf.

For the total respondents, the five most commonly endorsed health symptoms on the HSC in decreasing prevalence were: aches/pains, lack of energy, headaches, insomnia, and feeling nervous and tense. Comparisons among the three most frequently endorsed symptoms and their rank order differed somewhat between the high and moderate symptom groups (Table II). Respondents were asked to indicate qualitatively whether their health status had changed since their return; 30% indicated that their physical health had become either "worse" or "much worse." A comparable proportion (27%) reported that their psychological health had deteriorated similarly.

In univariate regression analyses, those with reported exposure to poison gas (OR = 6.3; 95%CI = 3.4, 8.6), transportation unit membership (OR = 1.6; 95%CI = 1.1, 2.2), or those with high combat exposure (OR = 3.2; 95%CI = 2.3, 4.4) were at significantly higher risk of reporting high, versus no, health symptoms.

In the final multivariate regression models after backward elimination, reported exposure to poison gas significantly predicted increased reports of health symptoms (Table III). Those veterans belonging to a transportation unit also were at increased risk, but the OR was not significantly greater than 1 (Table IV). Persons with higher combat exposure were not more likely to report increased health symptoms (Table V).

PTSD symptomatology, whether treated dichotomously or as a continuous symptom score, was significantly associated with high health symptom endorsement in all models. None of the models with the dichotomous PTSD variable, however, provided a better fit to the data than the continuous Mississippi PTSD score based on model goodness of fit determinations. Because a higher proportion of veterans with high combat exposure met criteria for presumptive PTSD compared to those with less combat exposure (22.0% vs 8.1%, χ^2 [1, n = 2119] = 67.4; $P < 0.001$) and a higher proportion of veterans reporting exposure to poison gas met criteria for presumptive PTSD compared to those not reporting this exposure (30.7% vs 10.1%, χ^2 [1, n = 2119] = 31.8; $P < 0.001$), interaction effects were tested for these two exposures. No significant interaction effects were observed.

When persons with presumptive PTSD (those with Mississippi scores >89) were excluded, and the regression analysis as presented in Table III was rerun, those persons who reported exposure to poison gas remained at higher risk for reporting a high number of health symptoms (OR = 9.1, 95%CI = 1.6, 51.9, $P = 0.01$; Model $\chi^2 = 559.0$, 7 df, $P < 0.0001$).

DISCUSSION

The range of health symptom endorsement in this cross-sectional, cohort study was broad: approximately one-half of the respondents reported no symptoms in the past several weeks, while 13% had prominent symptoms at a frequent rate. Although no concurrence on etiology exists,

TABLE II. Prevalence Rates (%) for Reporting of Individual Symptoms on the Health Checklist in a Study of Persian Gulf War Veterans

	Symptom prevalence in total study cohort (n = 2,119)	Symptom prevalence in high symptom group (n = 275)	Symptom prevalence in moderate symptom group (n = 836)
General aches and pain	22.7	77.1	30.4
Overly tired/lack of energy	22.2	78.2	30.7
Headaches	19.8	71.6	26.5
Trouble sleeping	17.5	66.9	22.3
Nervous or tense	15.0	76.0	13.1
Depressed mood	14.9	73.5	13.6
Difficulty concentrating	13.1	68.7	10.5
Upset stomach	12.9	54.5	14.7
Common cold or flu	12.0	34.5	19.0
Muscle twitches or trembling	9.5	49.6	7.9
Skin rashes	8.7	33.6	11.0
Loss of interest in TV, movies, news, friends	7.9	44.5	5.5
Hands sweaty and feel damp and clammy	7.0	39.7	4.7
Shortness of breath (not exercising)	5.9	34.9	3.5
Rapid heart rate (not exercising)	5.6	33.5	3.2
Feeling life is pointless, meaningless	4.8	31.3	1.9
Loss of appetite/loss of weight	4.7	26.2	3.3
Crying easily	4.5	25.8	3.0
Dizziness	4.0	22.6	2.6
Taking medication to sleep or calm down	3.1	20.7	1.0

TABLE III. Final Multivariate Logistic Regression Model of High Symptom Endorsement (Versus No Symptoms) as Predicted by Reported Exposure to Poison Gas or Germ Warfare (n = 1,283) in a Study of New England Area Persian Gulf War Veterans*

	Coefficient	SE	OR	95%CI	P
Reported exposure to "poison gas"	1.8	0.85	6.3	1.2, 33.3	0.03
Responded as "don't know"	0.29	0.52	1.3	0.48, 3.7	0.58
Unemployed	0.91	0.52	2.5	0.90, 6.9	0.08
Education level	0.13	0.09	1.1	0.95, 1.4	0.17
Female	1.8	0.56	6.4	2.1, 19.2	0.001
African American	−3.4	0.89	0.03	0.01, 0.20	<0.001
No. of months in Gulf	−0.22	0.13	0.80	0.62, 1.0	0.09
Depression subscale	2.2	0.33	9.4[a]	4.9, 17.9	<0.001
Somatization subscale	4.2	0.47	6.2[a]	4.2, 9.2	<0.001
Mississippi (PTSD) score	0.07	0.015	4.7[a]	2.4, 8.9	<0.001
Constant	−12.0	1.8			

*Model $\chi^2 = 1054.4$, 8 df, $P < 0.0001$.
[a]ORs represent comparison between those at 75th vs 25th percentile.

1991]. Each of these factors has been found to be associated with increased rates of reported health problems in other wartime conflicts [e.g., Kulka et al., 1990]. In terms of gender, the obtained difference is also consistent with data from the general population that indicate that women overall describe more health concerns, suffer more nonfatal, chronic illnesses, and seek more health-related services than men do [Verbrugge, 1985, 1989].

interaction of DEET and pyridostigmine bromide) interacted synergistically to produce many of the symptoms. However, support for this theory rests solely on initial preclinical models. Third, PGW symptoms could represent common sequelae of war-time deployment, irrespective of era, a hypothesis offered by other investigators (Hyams et al., 1996). Finally, prominent symptoms (e.g., headaches) might simply reflect problems that are widely prevalent in the general population [Kroenke and Price, 1993]. Still, the Iowa Persian Gulf Study Group [1997] found no increases in deployed veterans' rates of medical conditions not expected to be associated with Persian Gulf services, suggesting that symptom or disease reporting as a trend is unsubstantiated.

Only one published study we are aware of has examined whether subtypes of symptoms associated with PGW health problems exist [Haley et al., 1997] and whether these problems are distinctively linked to characteristics of this war or its exposures [Haley and Kurt, 1997]. Both reports reflect a number of methodological problems (low response rate, single unit cohort) [Landrigan, 1997]. These findings, like ours, suggest strongly that further study is needed at a more detailed level, that is, using population-based samples and/or more complex analyses in order to better characterize illness and its precise onset and endpoints.

To date, few investigations have tested the validity and specificity of veterans' symptom reports by concurrent examination of relevant comparison groups [Iowa Persian Gulf Study Group, 1997]. To compare our sample initially with an activated but nondeployed group, we administered the HSC during the same time period to a small cohort ($n = 38$) of New England-based, male National Guard members of similar age and regional background. Data from the nondeployed group revealed significantly fewer health symptoms (mean = 0.82, SD = 2.4) compared to a matched study subset drawn from our larger sample ($n = 905$; mean = 2.0, SD = 3.3, $P < 0.004$). These findings preliminarily suggest an association between increased health complaints and Persian Gulf deployment. Recently, a more comprehensive study of PGW deployed and nondeployed subjects found higher prevalences of symptoms of depression, PTSD, chronic fatigue, cognitive complaints, alcohol abuse, respiratory–pulmonary, and neuromuscular problems among PGW deployed personnel compared to their nondeployed counterparts [Iowa Persian Gulf Study Group, 1997].

A number of methodological issues constrain interpretation of the current findings. First, this study relied on cross-sectional data, precluding inferences about the course of illness or possible changes over time. Also, we assessed subjects only after their return from the Gulf and, since no reliable pre-deployment health data have been made available, it is not feasible to evaluate the rates of preexisting medical status or the possible contribution of pre-deployment conditions to post-war health outcomes. Given the breadth of premilitary and military occupations in such samples (including effects of previous war-zone deployments), the possibility of earlier toxicant exposure cannot be ruled out and is being examined in a subsequent study phase.

In addition to these issues, results may be impacted by the fact that studies investigating the sequelae of hazardous exposures are difficult to conduct for a number of reasons. First, both reliable reporting and accurate detection of exposure are affected when large amounts of time elapse between purported exposures and subsequent assessment. Some studies have found that survey instruments offer a valid and reliable method for collecting information on purported exogenous exposure [Hu et al., 1989]. On the other hand, our findings may be liable to the same problems in a number of retrospective studies, which show that reports of exposure and symptoms are vulnerable to recall bias [Neugebauer and Ng, 1990; Chouinard and Walter, 1995]. This bias can represent factors ranging from social desirability (e.g., following intense media attention) to marked variations in individual sensitivity to physiological status [Desimone, 1992]. On the other hand, our data were collected in 1992, well before most media and public attention on health outcomes developed.

Reported or perceived exposure to chemical warfare could represent a unique combination of many factors, including attributions about the effects of hazardous exposure, individual associations between health status and other potentially hazardous sources (e.g., ingestion of anti-nerve gas pills), and demonstrated linkages between health status and subsequent psychological stress. Indeed, the fact that some veterans did change their endorsement of chemical/germ warfare exposure from Time 1 to Time 2 suggests that a number of differing factors (e.g., deterioration in health, development of PTSD) could be operational in influencing descriptions and recollections of salient experiences. Still, none of these factors preclude the possibility that actual hazardous exposure occurred, supporting the need for rapid, detailed studies involving more objective exposure indices (e.g., geographical location, mapping of individual troop movements over time, chemical exposure modeling data). These studies would help address the generalizability of our findings to other populations (e.g., other Allied forces; other military theaters).

In conclusion, we have identified a number of variables associated with adverse health complaints among participants in the PGW. The presence of psychological symptoms, such as PTSD, general distress, intervening life stressors, and decreased social support, all predicted higher levels of reported health symptoms, consistent with prior research. However, most likely they are not the only explanation. In light of recent reports by the Department of Defense that veterans in certain locations may have been exposed to low-level nerve agents, this study's findings suggest a

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